Using Time-Phased Casualty Estimates to Determine Medical Resupply Requirements

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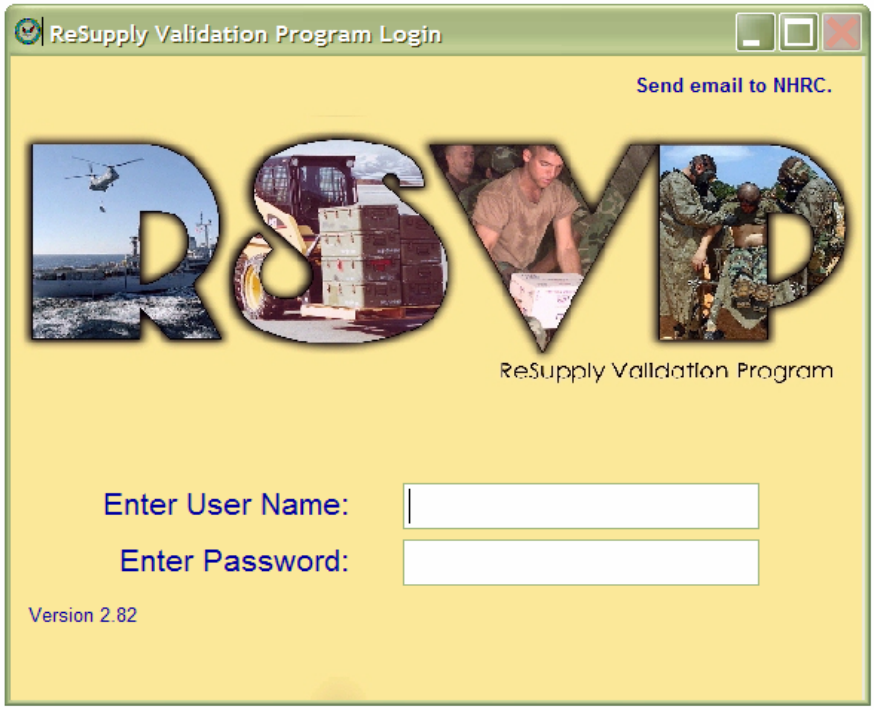

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Executive Summary

Background

The means of supplying and resupplying medical materiel needs to be efficiently managed. In order to achieve objectives like greater battlefield mobility, increased speed, and force flexibility for a wide variety of operations, it is especially important that supplies are not only directly related to those missions but also that appropriate quantities are available.

Resupply of medical materiel has come of age. It needs to follow in the footsteps of initial supply requirements and become part of the process that models sustainment on real-time casualty data. Because planning and outfitting medical missions require predicting a future as yet unrealized, the resupply process can be more automated and precise by aligning it with real casualty data.

The US Marine Corps (USMC) missions set the guidelines for configuring supply modules that determine the scope of care provided at individual treatment facilities, and this drives the decisions concerning how best to equip medical personnel in theater so they can respond most efficiently to warfighter needs. Adequately equipping these facilities is a challenge that requires knowledge of planning factors like expected casualty rates and potential illnesses and injuries. In this study, the Naval Health Research Center (NHRC) modeling programs focused first on the capability, on the clinical services performed at the treatment facility, using clinical requirements to indicate tasks performed and supplies necessary to fulfill that facility's mission. The clinical requirements were then tied to actual patient conditions, creating a logical methodology for establishing initial requirements. Subsequently, NHRC researchers used their underlying data to tackle the resupply process. They also used the data to ensure that the proper assets are always available, not just at the outset of an operation, but as time proceeds and the mission requires medical sustainment.

Objective

The primary objective of this paper is to explain the process for submitting a Medical Contingency File (MCF) using NHRC's modeling tools, the Estimating Supplies Program (ESP) and the ReSupply Validation Program (RSVP). MCFs are used by the Defense Supply Center Philadelphia (DSCP) to place supply orders with vendors.

ESP links specific clinical requirements to medical procedures, making estimations of supply requirements more reliable and tying them to real-time casualty data. RSVP models supply consumption over time, and produce reports, like the MCF submittal, that were created with medical planners and logisticians in mind. The audit trail, produced by the process of running a user-defined patient stream through a simulation, provides users with management tools for ordering, maintaining, and updating supply inventories, allowing them to see how quantities are utilized over time within varying scenarios.

Approach

This paper delineates the process created to automate and manage resupply for the Navy-Marine Corps medical treatment facilities, as well as Maritime Prepositioning Ships by using ESP and RSVP to generate reports that will function as both a means of ordering supplies and maintaining them based on real-time casualty data.

The discussion takes the program user through the process screen by screen, describing the inner workings such that the entire process makes sense, and ends by showing examples of files that are generated by user-defined scenarios.

Conclusion

USMC doctrine requires more mobile, modular, flexible, and deployable medical care systems. USMC researchers use NHRC programs to conduct their Authorized Medical Allowance List reviews and, since June 2004, to generate resupply orders. NHRC would like to make this process available to all the services. Utilizing ESP to establish initial requirements by linking supply line items to the clinical tasks performed to consume them is the first step in determining the appropriate type and number of supply items required for the delivery of care. Following up with RSVP to prepare sustainment requirements that are then placed with DSCP as vendor orders for medical materiel is the logical end toward which the services wish to progress.

Introduction

To create more flexible, effective combat operations as outlined in the *Naval Force Health Protection for the 21st Century*, *Joint Vision 2020*, *Marine Corps Strategy 21*, and *Sea Power 21*, NHRC developed the Estimating Supplies Program (ESP) to prepare and validate initial Authorized Medical Allowance Lists (AMALs) so that all Navy-Marine Corps medical treatment facilities (MTFs) would be equipped with supplies appropriate to their given missions. Subsequently, NHRC developed the ReSupply Validation Program (RSVP) to streamline the sustainment process for all US Marine Corps (USMC) AMALs and Authorized Dental Allowance Lists (ADALs).

The USMC validates its medical supply lists using ESP because the program can formulate a mathematical distribution of patients that represent the number and type of injuries and illnesses for a given concept of operations. ESP then generates an inventory linked to that particular patient stream, from which its companion program, RSVP, configures resupply values based on anticipated consumption rates.

One of the ways it resupplies AMALs and ADALs is to generate Medical Contingency Files (MCFs) in RSVP, which it then forwards to DSCP to prepare a vendor managed inventory contract for supply procurement. This paper describes the process by which the medical planner and logistician may respond to a request for an MCF submittal, creating a report using ESP and RSVP that puts the resupply process in motion.

Background

In the past, sustainment or resupply requirement estimates for maintaining AMAL inventories were based on assumptions regarding number of patients, lab tests, and various other metrics like days of supply (DOS). This process did not rely on a defined casualty rate for a Marine Expeditionary Force over a 60-day period, and produced estimates based on AMAL configurations or on assumed utilization and consumption rates proportional to the number of supply items in an AMAL or ADAL. Using one or more of these variables to estimate resupply contributed to excess inventory requirements for some items. Sustainment requirements would be better based instead on casualty streams, proscribed clinical standards of care, and the materiel required to perform those tasks.

An overview of the process outlined in this paper appears in Figure 1, which depicts the steps required to generate an MCF submittal, beginning with data collection. ESP casualty data include injuries and illnesses from historical missions like those carried out in Southeast Asia or Southwest Asia. Using these data, the program creates a patient stream based on probabilities—the likelihood of a particular condition occurring—and estimates wounded in action (WIA) and disease and nonbattle injury (DNBI) rates. It forecasts initial requirements and then transfers the patient stream information to RSVP, where these underlying data are linked to user-defined

parameters for resupply. RSVP configures and time-phases the supplies according to the data and generates a line-item list, or an MCF submittal form, to send out.

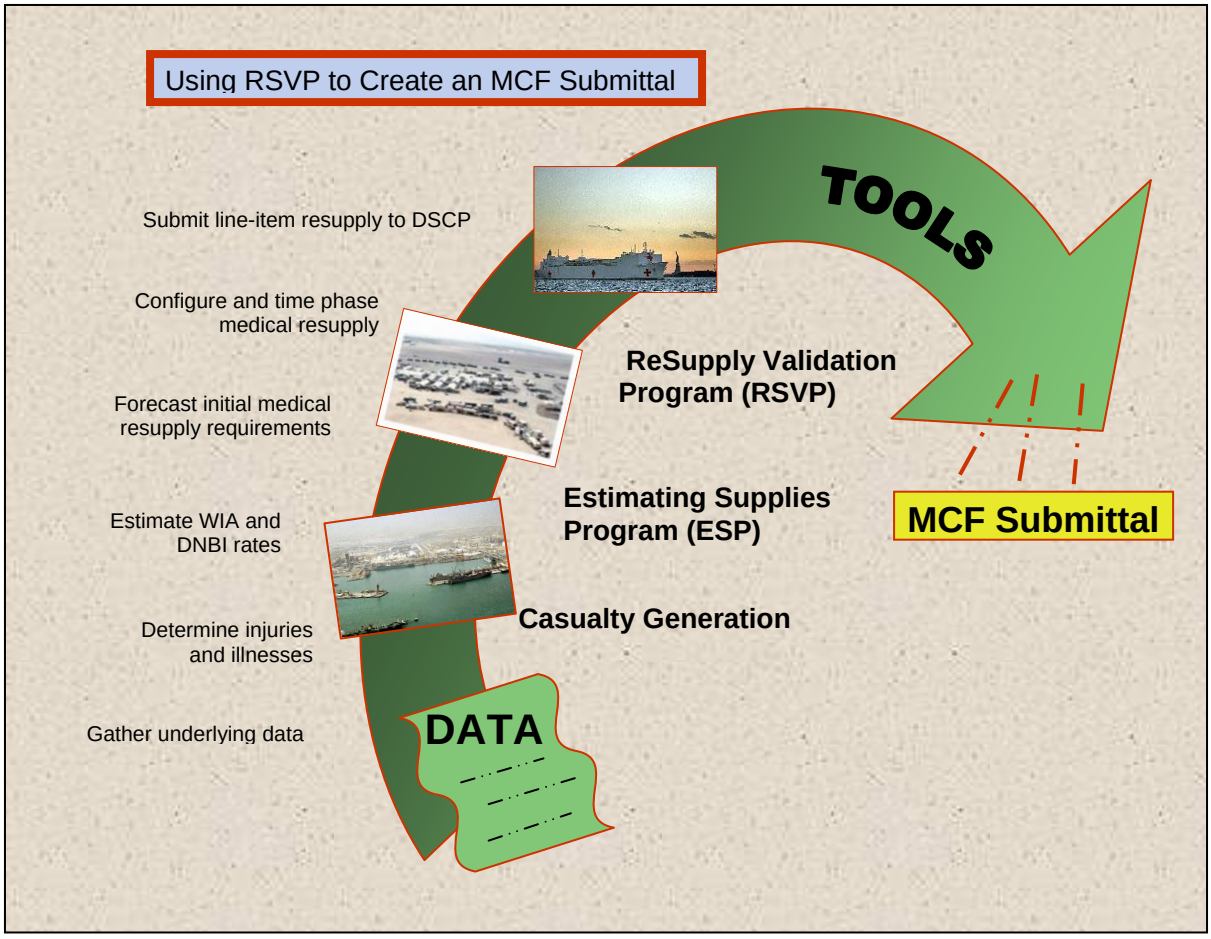


Figure 1. Using RSVP to generate a Medical Contingency File (MCF) submittal. DSCP indicates Defense Supply Center Philadelphia; WIA, wounded in action; DNBI, disease and nonbattle injury.

The Estimating Supplies Program (ESP)

The USMC need to outfit a more mobile, flexible force highlighted the necessity of creating initial and resupply inventories that better reflected actual patient care and supply usage. To address this need, NHRC developed ESP and RSVP,[1,2] expressly for creating a relationship between MTFs configured for specific types of casualty care and those tasks required to treat them in a combat situation. They aimed to arrive at an appropriate mix of supplies that was ample enough to treat injuries and illnesses likely to occur on today's battlefields. NHRC had at its disposal real casualty data, the Defense Medical Standardization Board patient condition (PC) codes, and subject matter experts (SMEs) to consult regarding tasks and supplies.

At the outset, ESP was outfitted with underlying data from previous missions representing real casualties and lending an accuracy previously lacking to its task of

creating a patient stream from which to develop realistic supply needs. ESP inputs are organized into scenarios distinguished by variable elements, but all include PCs, levels of care, and functional areas (FAs) in which patients are treated and supplies used.[3] To create an initial requirement, NHRC chose a high-intensity battle or a worst-case scenario, ensuring that the model provided for the greatest number of medical contingencies. Once a patient stream was generated, SMEs weighed in on which tasks are performed to administer care to those particular patients and reviewed supplies to determine which ones were redundant or obsolete. ESP then linked the tasks to the supplies needed to carry them out. The chain complete, ESP generated reports and spreadsheets of individual supply items necessary for the patient stream, sorted by MTF and organized by the FA in which they were used.[4]

In this way, AMALs were initially populated with a worst-case scenario load of supplies, while excluding redundant or obsolete supplies. This modeling process reduced inventory by more than 30% and, furthermore, established a clinical requirement for each line item, which in turn yielded sustainment requirements that are based on a defined capability.[5] Not only did ESP enhance the USMC's effort to establish an initial supply requirement, this symbiotic relationship now allows the AMAL review process and ESP to continually inform one another and indicate the path the resupply process can take. Furthermore, the US Air Force has followed suit and is benefiting in similar ways in its effort to establish and maintain supply requirements that reflect defined and documented capability requirements.

The ReSupply Validation Program (RSVP)

The resupply process has undergone a recent shift, from issuing medical supplies according to a DOS matrix to stocking and resupplying based on consumption forecasts. ESP's resupply function, RSVP, automates the semiannual USMC requirement review process, and has been used since June 2004 to develop the Class VIIIA requirements submitted to DSCP for sustainment planning.

DSCP is the repository for all the services' Class VIIIA sustainment requirements, and uses the data to develop contingency contracts from the services with the commercial industry base to support materiel sourcing. Line items are placed in Excel spreadsheets, evaluated, and sent as inventory resupply requirements.

The USMC has been tasked to use RSVP forecasts, because they are clinically based on ESP's underlying data. RSVP generates resupply estimates based on casualty treatment utilization rates by using ESP scenario parameters to develop a casualty stream, and linking supplies and treatment protocols to PCs. It distributes the required supplies over 6 to 10 time intervals to cover patients as they arrive in Level 1 and 2 MTFs, showing which supplies will last, which need to be re-ordered, and during which period they may run out. All casualty rates and PCs are based on real data and on a consumption or usage rate. To do this, RSVP runs the patient stream through a scenario that simulates patient usage, decrementing supplies as injuries are treated over time, and then creates reports that show just how those supplies are utilized, when they run out, and when new supplies need to be ordered.

In June 2004, NHRC responded to a request from Headquarters Marine Corps, Installations and Logistics, for instruction on USMC MCF submittal. This document describes the process and provides some guidance for future responses

Methodology

To accomplish the task of creating and forwarding an MCF using ESP, the user creates a patient stream, entering in variables such as battle intensity, PCs including specific injuries and diseases, levels of care, and FAs in which patients are treated. To ensure the patient stream reflects the nature of the mission for which supplies are estimated, the program makes sure that one of each PC is represented in the model. Once the patient stream is populated and the initial supply list has been generated, the planner produces reports that allow line-item review from which to develop one or more MCFs to forward to DSCP for sustainment procurement.

Using ESP involves understanding how to extract its underlying data, which consist of about 400 different PCs that are linked to tasks required to treat the conditions, and subsequently, to those supplies necessary to complete the tasks. The patient stream is a series of PCs based on user-defined mission scenarios that contain real casualty data. Users may select a scenario approximating the type of patient stream they want to simulate, or they may build their own scenarios based either on PCs or injuries and diseases they want to include.

Creating an MCF Submittal

In the example that follows, the user creates an MCF submittal by utilizing both ESP and RSVP. To begin, the user enters the Scenario Wizard in **ESP** (Figure 2) and selects either an already-created scenario, or builds one by PC or disease type. The initial supply order generated reflects the patient stream specified by the user, so that if, for example, a heavy battle intensity scenario is chosen, ESP creates a model that reflects that type of robust patient stream in order to populate a supply list that will be capable of treating the possible injuries.

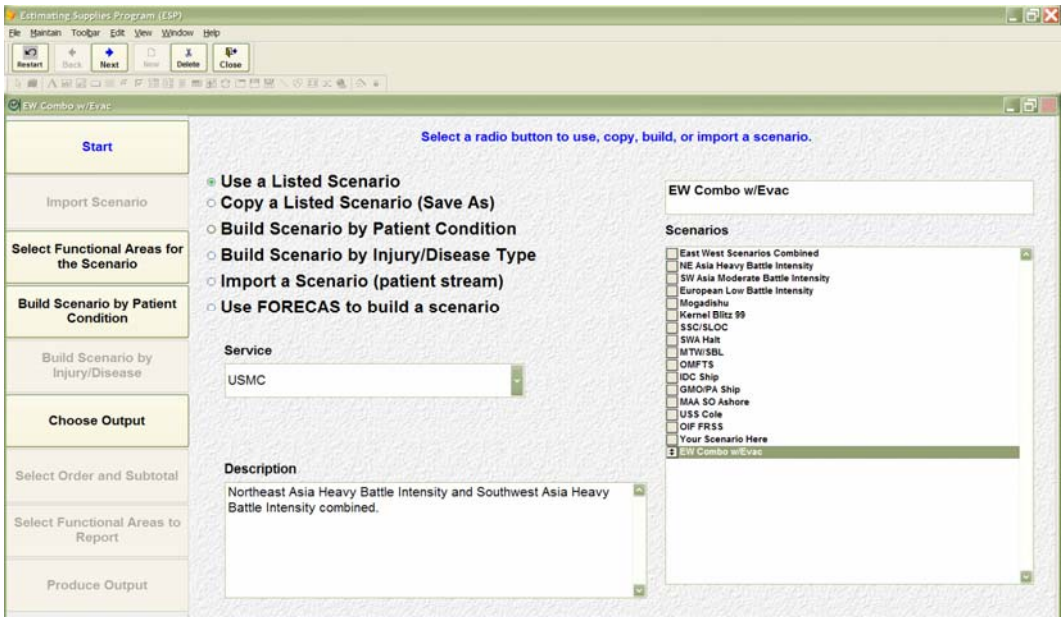


Figure 2. The Start tab in the ESP Scenario Wizard screen.

Once the scenario has been selected or built, the user exits out of ESP and opens **RSVP**, which is set up to systematically construct an MTF laydown and then calculate a supply list that provides materiel to each MTF and FA in the constructed network.

The first screen within RSVP is the Inventory Generator (Figure 3). The scenario selected within ESP appears in RSVP because RSVP draws on ESP's underlying data to create a patient stream from the casualty data gathered during that operation (in this case, the **EW Scenario with Evac**). Once the user selects the scenario, it becomes the template on which RSVP bases its calculations

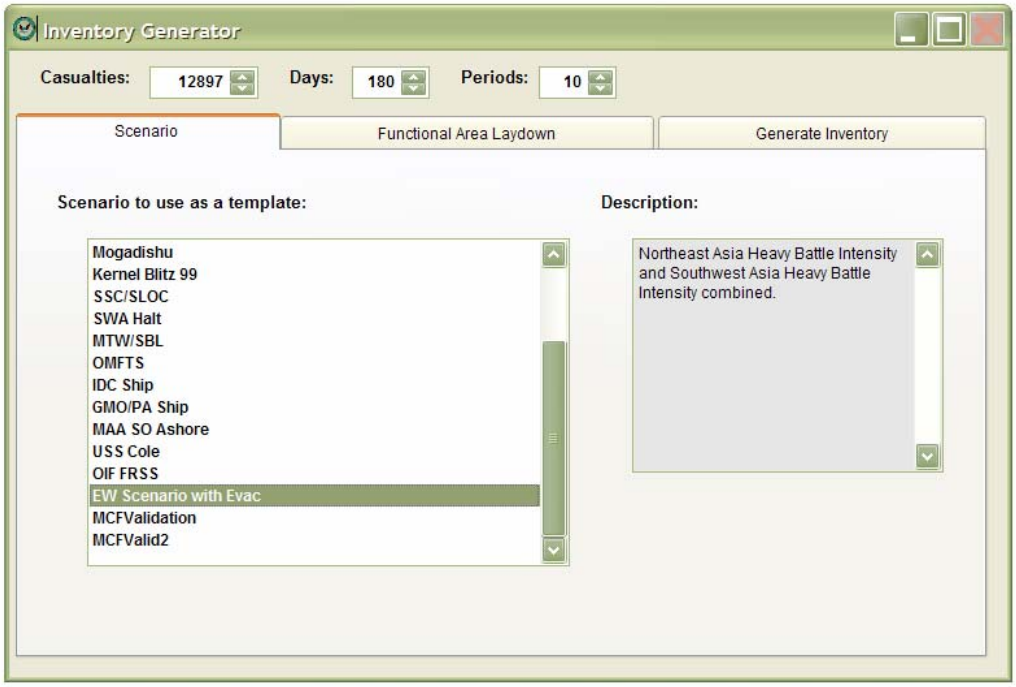


Figure 3. The Scenario tab in the RSVP Inventory Generator screen.

At the top of the screen are boxes that indicate the numbers of casualties (12,897), days the scenario lasts (180), and time periods (10) for resupply delivery. Visible in the Description box in Figure 3 is an explanation of the kind of casualty data the scenario includes. The **EW Scenario with Evac** is based on data from Northeast and Southwest Asia, and is characterized by heavy battle intensity, so it is understood that there will be a large number of casualties with a variety of injuries, chosen purposely for this simulation, whose task is to generate resupply for just this sort of operational tempo. This number can be changed to any value the user forecasts.

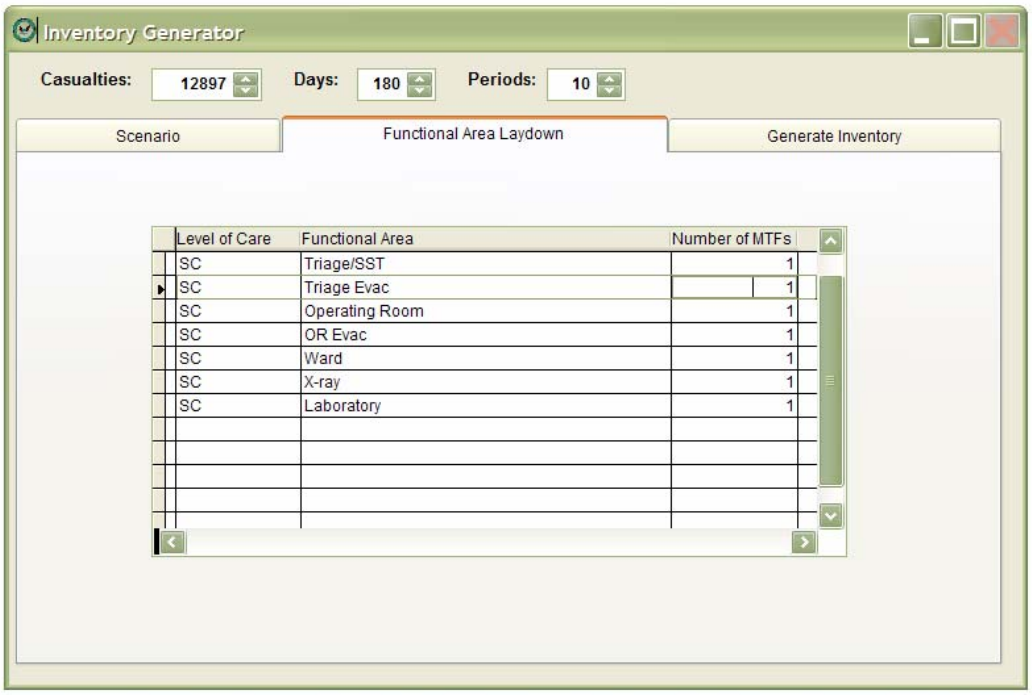


Figure 4. The Functional Area Laydown tab in the RSVP Inventory Generator screen.

Following the tabs across the screen, the user selects the Functional Area Laydown tab and a dialog box opens within which the user chooses FAs, specifying the number and type to be included in the network (Figure 4). FAs might include an Operating Room (OR) capability, a pre- and post-OR, Laboratory, Ward, Forward Resuscitative Surgical System (FRSS), or Surgical Company (SC) areas, depending on the medical treatment laydown that the mission requires. For example, if a mission does not involve fixed facilities, X-ray and Laboratory functions are unnecessary, so consumables and equipment that populate those FAs are not included.

The **EW Scenario with Evac** includes First Responder, Battalion Aid Station (BAS), FRSS, SC, and finally Evac capabilities for each FA, but excludes SC Preventive Medicine. The user adds Evacuation (Evac) and En Route Care FAs so that all Level 1 and 2 care facilities are represented in the supply order.

Table 1. Patient Stream Casualties, by Percentage and PC Category

Percentage	PC Category
2.68%	Abdomen & Pelvis
8.92%	Battle Fatigue
2.23%	Burns
0.17%	Cardiovascular
6.16%	Dermatological
0.39%	Directed Energy Weapon Eye Lesion
2.01%	Environmental
2.06%	Eye/Ear Disease
0.83%	Female Specific
13.48%	Gastrointestinal
0.19%	General
0.39%	Genitourinary
4.45%	Head
4.89%	Infectious/Parasitic
8.96%	Lower Limbs
4.99%	Multiple Injury Wounds
0.63%	Miscellaneous
2.25%	Neuropsychiatric
14.45%	Respiratory
2.29%	Sexually Transmitted Disease
0.46%	Spine
1.24%	Sprains & Strains
7.37%	Superficial/Soft Tissue
1.38%	Surgical
1.61%	Thorax
5.54%	Upper Limbs

Table 1 shows the breakdown by category of injuries that casualties may incur and the percentage of each type of injury, the basis on which RSVP calculates resupply. Using this scenario, NHRC ran the simulation 100 times (each run is called an iteration) in order to calculate supplies for 180 days' sustainment.

RSVP uses a Monte Carlo simulation to randomly draw PCs based on their probability distributions and arrival times for each patient. If a PC does not appear, the program goes back through and adds one patient for each omitted PC. In this way, it ensures that a minimum of materiel is present in the supply order to deal with whatever sort of injury arises. The patient stream is then used to simulate supply utilization rates.

With each iteration it runs, RSVP randomly selects which PCs will appear in that particular run's patient stream. It may be useful to envision this randomization as a process that places each PC as a pie section on a "wheel." Each section is sized in relation to the probability that the PC it represents will occur. Those PCs with larger probability of occurrence percentages have larger pie slices and therefore a greater

chance of being selected by the "spinning wheel." RSVP then "spins" the wheel to determine which PC each casualty exhibits upon arrival and then spins another wheel to determine when the casualty arrives, until it processes all 12,897 casualties. RSVP then starts another run at the beginning, "spinning" to create a stream, and repeats this process 100 times.

Once RSVP has done this random draw 100 times, instead of taking an average, the program selects the greatest number of patients for each PC across the 100 iterations, to create a robust inventory capable of equipping medical facilities for any possibilities they might encounter.

RSVP distributes supplies with regard to packaging, calculating those quantities necessary to treat the patient stream based on NOT breaking up packages. This means that if a bottle of pills contains 1000 pills and the patient stream calls for only 400, the supply order includes one bottle for each MTF. If there are three MTFs that each require a supply of the pills, RSVP reports that three bottles are required.

Packages are added to distribute supplies to multiple MTFs at each level of care. To modify this behavior, the user simply enters one MTF for each FA. It is assumed that supplies will then be divided appropriately when they are delivered.

After calculations, quantities are rounded up to the package quantity and then reduced in subsequent periods based on expected use of remaining unused supplies.

The next step is to generate inventory. In RSVP, the user distributes patients over time by selecting a time frame and then dividing the patients into it; in this case, a relatively constant distribution of patient arrivals is chosen. Patients are equally divided across a 6-month (180 days) period; the first 6 periods are 10-day slots.

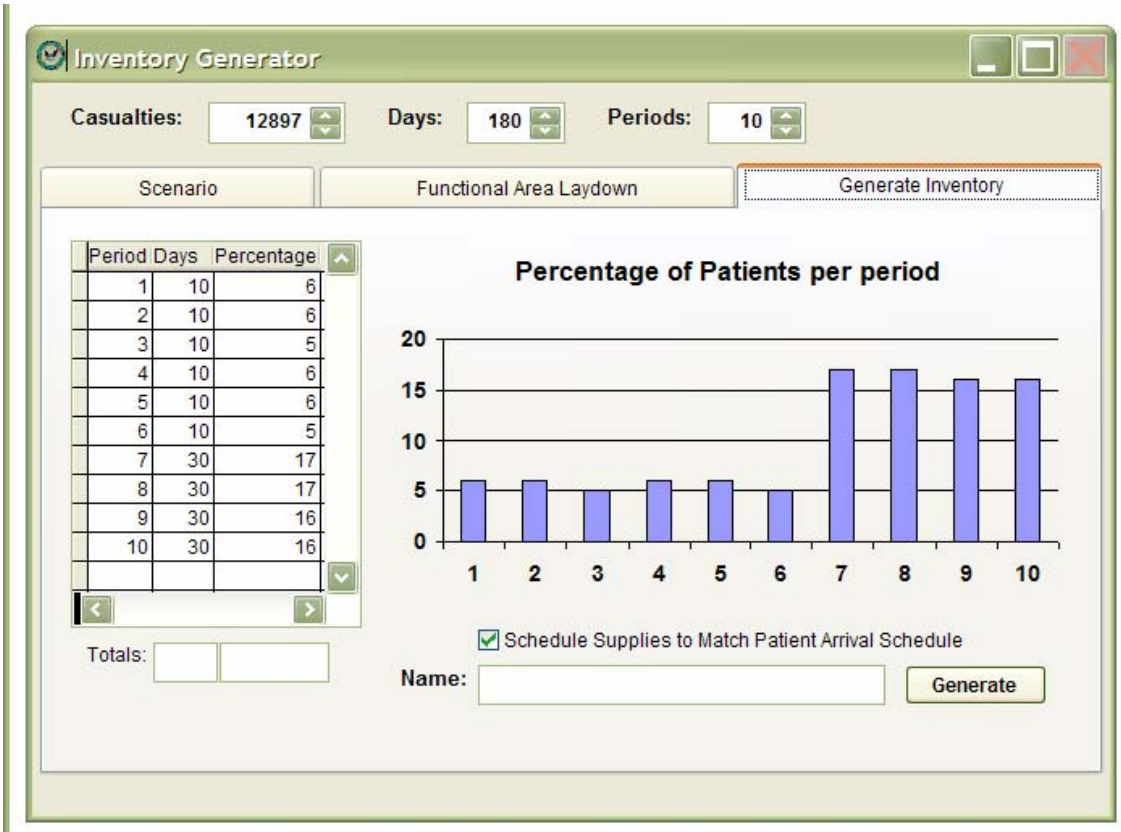


Figure 5. The Generate Inventory tab in the RSVP Inventory Generator screen.

Clicking on the Generate Inventory tab, the user manipulates the graph at the right of Figure 5 by changing the percentages in the table at left. This sample phases supplies over time such that they correspond to patient arrivals, but users may vary the supply arrival schedule. For example, if they want all supplies to arrive at once at the beginning of the mission, they can simulate that by placing 100% in the first period.

The box indicating "Schedule Supplies to Match Patient Arrival Schedule" can be checked, a name entered for the Inventory, and the Generate button clicked. To have the supply arrival schedule differ from the patient arrival schedule, users may elect to not check the box, in which case they are required to plan the supply deliveries before running a simulation.

Breaking the first 2 months into groups of 10 days each, the distribution of patients over time looks like that shown in Table 2. The user indicated that the patients should arrive in a steady stream, with subtle decreases toward the end of the first and second months (periods 3 and 6).

Table 2. Casualty Distribution by Period and Numbers

Period #	Period	Casualties*
1	Days 1 to 10	774
2	Days 11 to 20	774
3	Days 21 to 30	645
4	Days 31 to 40	774
5	Days 41 to 50	774
6	Days 51 to 60	645
7	Month 3	2192
8	Month 4	2192
9	Month 5	2064
10	Month 6	2064

*Number of casualties as they arrive at medical treatment facilities.

The supplies are tied to this distribution over time. The AMALs containing the supplies that correspond to the FAs selected for this patient stream are defined in Table 3.

Table 3. AMALs by Number (or Letter) and Contents*

0618	Laboratory Equipment	BEE	BAS ERC – Equipment
0619	Laboratory Consumables	FEC	FRSS ERC – Consumables
0627	X-Ray Equipment	FEE	FRSS ERC – Equipment
0631	SST/Triage Equipment	FOC	FRSS – OR Consumables
0632	SST/Triage Consumables	FOE	FRSS – OR Equipment
0633	Ward Equipment	FPC	FRSS – Post Op Consumables
0634	Ward Consumables	FPE	FRSS – Post Op Equipment
0635	Aid Station Equipment	FST	FRSS – Site Setup
0636	Aid Station Consumables	FTC	FRSS – Pre-Op Consumables
0639	Operating Room Equipment	FTE	FRSS – Pre-Op Equipment
0640	Operating Room Consumables	OEC	OR ERC – Consumables
1RC	First Responder – Consumables	OEE	OR ERC – Equipment
1RE	First Responder – Equipment	TEC	Triage ERC – Consumables
BEC	BAS ERC – Consumables	TEE	Triage ERC – Equipment

*BAS indicates Battalion Aid Station; ERC, En Route Care; FRSS, Forward Resuscitative Surgical System; SST, Shock Surgical Team/Triage.

Next in the process, a dialog box appears asking if this is an MCF submittal run, and the user clicks the Yes button to proceed.

Once the inventory has been generated, another dialog box signals that a file has been created. The user now navigates to the Inventory Reports screen from the main menu by using the pull-down menu under Reports and selecting Inventory.

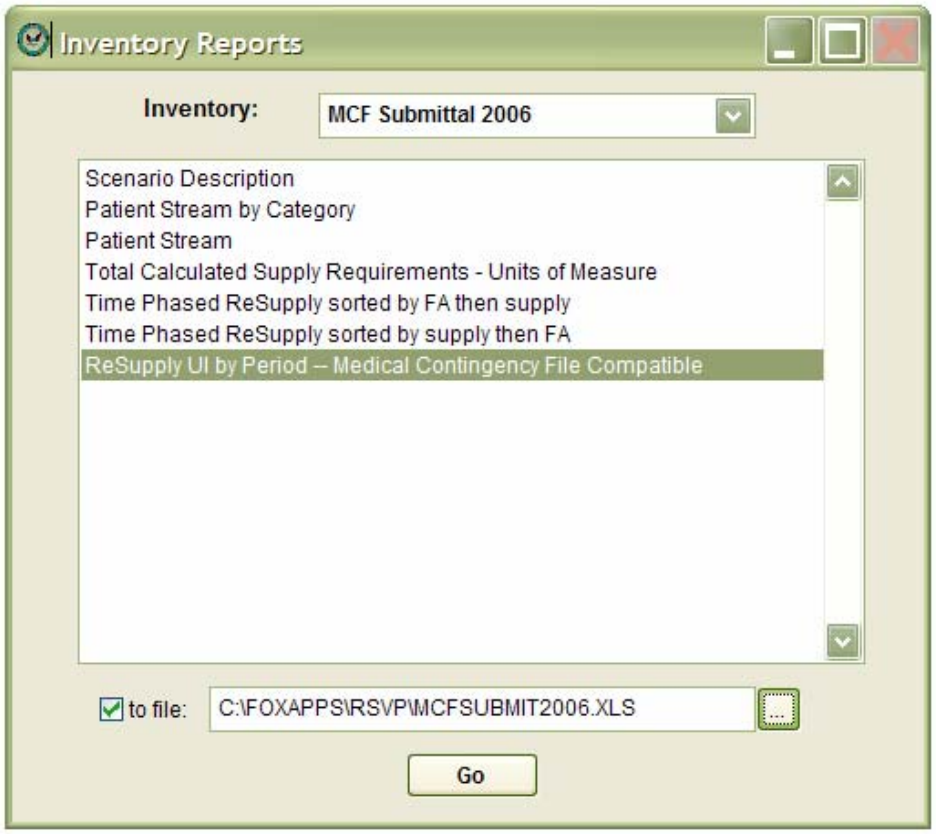
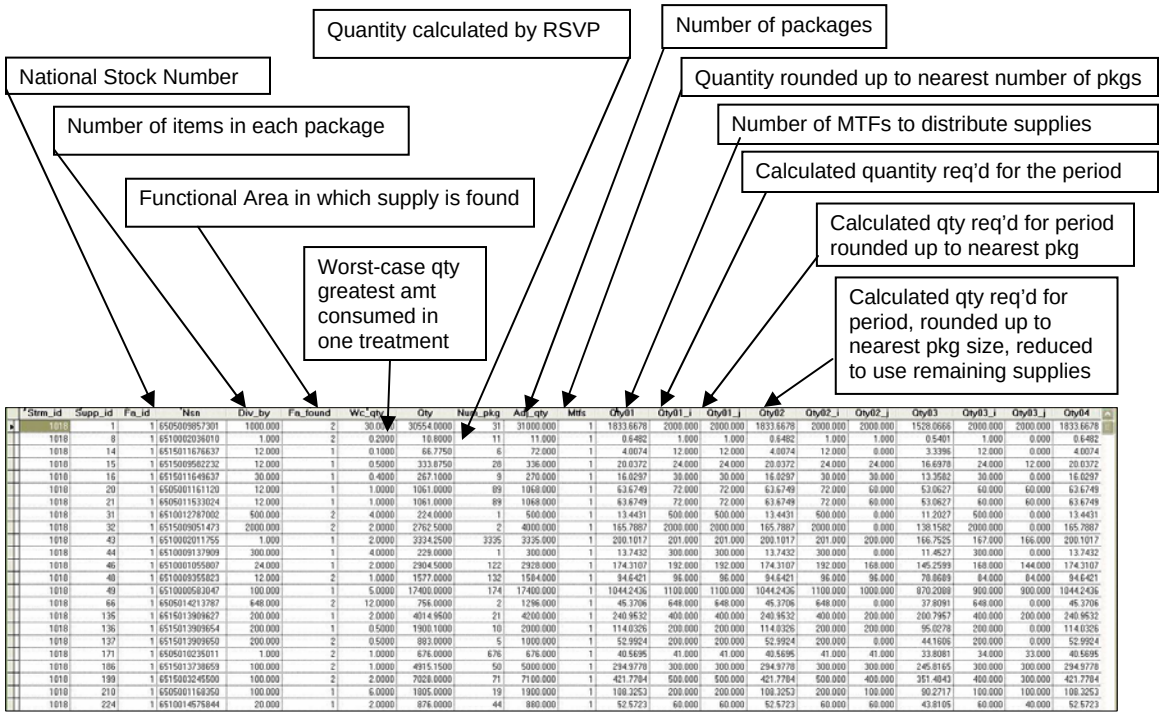


Figure 6. The Inventory Reports Screen.

The pull-down menu at the top contains, among other files, the file just created, so the user selects that file name and then selects the *Medical Contingency File Compatible* report. Next, the user checks the box to send the results to an Excel spreadsheet and enters a file name and location. The application reminds the user to send the output to an Excel file.

RSVP produces a distribution file, as shown in Figure 7, that contains the supply descriptive information, MTFs, packaging information, and calculated supply quantities distributed over the user-defined periods. This file is used as input for a program that names the periods, inserts AMAL identification numbers, calculates AMAL quantities for all items, identifies missing AMAL items, replaces equipment quantities with AMAL quantities, compares results to previous submittals, compares results to ESP, and produces two results tables shown later in Figures 9 and 10.

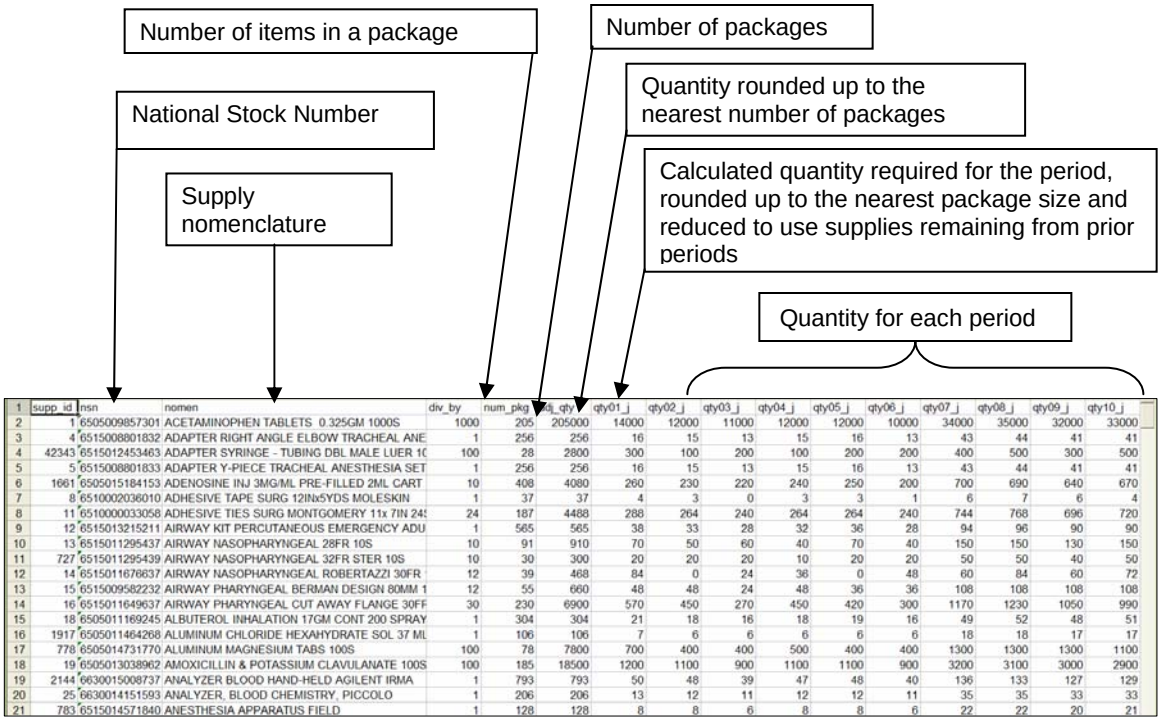


Strm_id	Supp_id	Fa_id	Nsn	Div_by	Fa_found	Wc_qty	Qty	Num_pkg	Adj_qty	Mtfs	Qty01	Qty01_i	Qty01_j	Qty02	Qty02_i	Qty02_j	Qty03	Qty03_i	Qty03_j	Qty04
1018	1	1	6505009857301	1000.000	2	30.0000	30554.0000	31	31000.000	1	1833.6678	2000.000	2000.000	1833.6678	2000.000	2000.000	1528.0666	2000.000	2000.000	1833.6678
1018	8	1	6510002036010	1.000	2	0.2000	10.8000	11	11.000	1	0.6482	1.000	1.000	0.6482	1.000	1.000	0.5401	1.000	0.000	0.6482
1018	14	1	6515011676637	12.000	1	0.1000	66.7750	6	72.000	1	4.0074	12.000	12.000	4.0074	12.000	0.000	3.3395	12.000	0.000	4.0074
1018	15	1	6515009582232	12.000	1	0.5000	333.8750	28	336.000	1	20.0372	24.000	24.000	20.0372	24.000	24.000	16.6978	24.000	12.000	20.0372
1018	16	1	6515011649637	30.000	1	0.4000	267.1000	9	270.000	1	16.0297	30.000	30.000	16.0297	30.000	30.000	13.3582	30.000	0.000	16.0297
1018	20	1	6505001161120	12.000	1	1.0000	1061.0000	89	1068.000	1	63.6749	72.000	72.000	63.6749	72.000	60.000	53.0627	60.000	60.000	63.6749
1018	21	1	6505011533024	12.000	1	1.0000	1061.0000	89	1068.000	1	63.6749	72.000	72.000	63.6749	72.000	60.000	53.0627	60.000	60.000	63.6749
1018	31	1	6510012787002	500.000	2	4.0000	224.0000	1	500.000	1	13.4431	500.000	500.000	13.4431	500.000	0.000	11.2027	500.000	0.000	13.4431
1018	32	1	6515009051473	2000.000	2	2.0000	2762.5000	2	4000.000	1	165.7887	2000.000	2000.000	165.7887	2000.000	0.000	138.1582	2000.000	0.000	165.7887
1018	43	1	6510002011755	1.000	1	2.0000	3334.2500	3335	3335.000	1	200.1017	201.000	201.000	200.1017	201.000	200.000	166.7525	167.000	166.000	200.1017
1018	44	1	6510009137909	300.000	1	4.0000	229.0000	1	300.000	1	13.7432	300.000	300.000	13.7432	300.000	0.000	11.4527	300.000	0.000	13.7432
1018	46	1	6510001055807	24.000	1	2.0000	2904.5000	122	2928.000	1	174.3107	192.000	192.000	174.3107	192.000	168.000	145.2589	168.000	144.000	174.3107
1018	48	1	6510009355823	12.000	2	1.0000	1577.0000	132	1584.000	1	94.6421	96.000	96.000	94.6421	96.000	96.000	78.8689	84.000	84.000	94.6421
1018	49	1	6510000563047	100.000	1	5.0000	17400.0000	174	17400.000	1	1044.2436	1100.000	1100.000	1044.2436	1100.000	1000.000	870.2030	900.000	900.000	1044.2436
1018	66	1	6505014213787	648.000	2	12.0000	756.0000	2	1296.000	1	45.3706	648.000	648.000	45.3706	648.000	0.000	37.8091	648.000	0.000	45.3706
1018	135	1	6515013909627	200.000	1	2.0000	4014.9500	21	4200.000	1	240.9532	400.000	400.000	240.9532	400.000	200.000	200.7957	400.000	200.000	240.9532
1018	136	1	6515013909654	200.000	1	0.5000	1900.1000	10	2000.000	1	114.0326	200.000	200.000	114.0326	200.000	200.000	95.0278	200.000	0.000	114.0326
1018	137	1	6515013909650	200.000	2	0.5000	883.0000	5	1000.000	1	52.9924	200.000	200.000	52.9924	200.000	0.000	44.1606	200.000	0.000	52.9924
1018	171	1	6505010235011	1.000	2	1.0000	676.0000	676	676.000	1	40.5695	41.000	41.000	40.5695	41.000	41.000	33.8081	34.000	33.000	40.5695
1018	186	1	6515013738659	100.000	2	1.0000	4915.1500	50	5000.000	1	294.9778	300.000	300.000	294.9778	300.000	300.000	245.8165	300.000	300.000	294.9778
1018	199	1	6515003245500	100.000	2	2.0000	7028.0000	71	7100.000	1	421.7784	500.000	500.000	421.7784	500.000	400.000	351.4843	400.000	300.000	421.7784
1018	210	1	6505001168250	100.000	1	6.0000	1805.0000	19	1900.000	1	108.3253	200.000	200.000	108.3253	200.000	100.000	90.2717	100.000	100.000	108.3253
1018	224	1	6510014575844	20.000	1	2.0000	876.0000	44	880.000	1	52.5723	60.000	60.000	52.5723	60.000	60.000	43.8105	60.000	40.000	52.5723

Figure 7. Distribution file showing supply descriptive information. RSVP indicates ReSupply Validation Program; MTFs, medical treatment facilities.

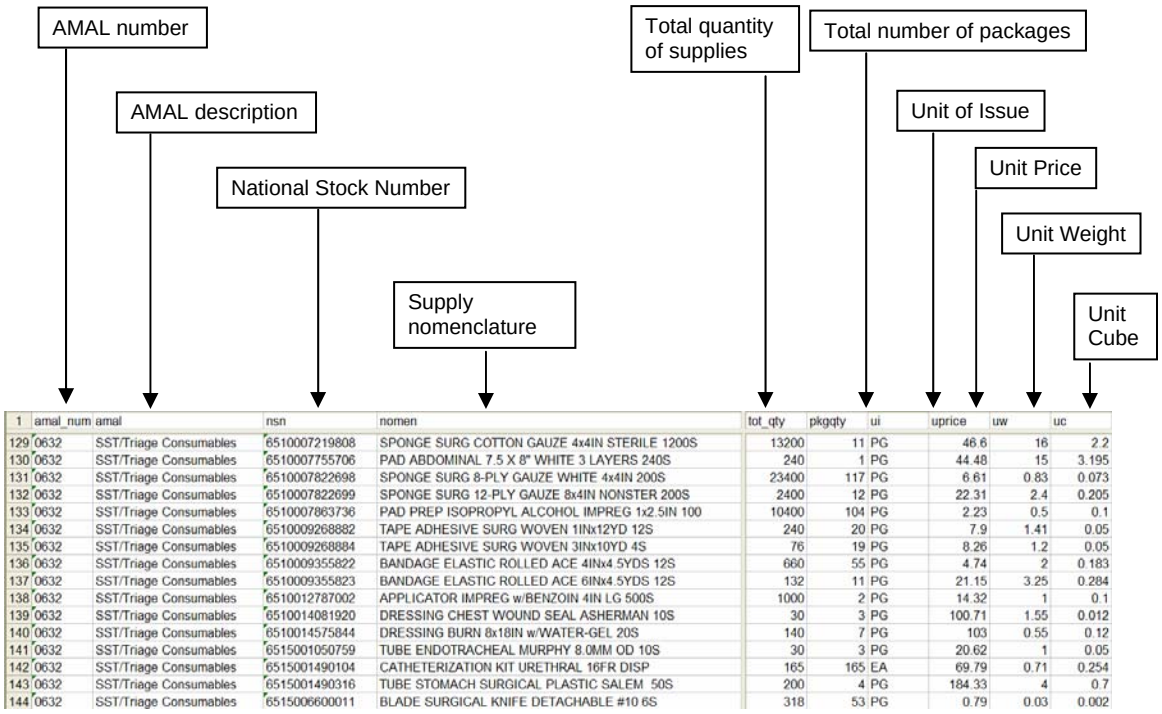
Figure 7 shows a compilation of the inputs required to create an Excel spreadsheet, and shows how supplies are distributed by quantity within FAs, across MTFs, and over the course of the mission. To reflect usage, this RSVP report calculates supply quantities by number of packages, rounds them up to comply with actual amounts per package, and reduces amounts based on leftover quantities from previous periods.

Figure 8 shows a spreadsheet the program also produces that contains the relevant information for each supply item, organized by National Stock Number (NSN). It breaks out the quantity of supplies in each period over the entire length of the 180-day mission. It includes the number of items per package, the number of packages, the quantity for each period rounded up and reduced to reflect usage in previous periods, and a quantity per item for each period in the mission. If the rounding of the quantities results in some supplies not being consumed in a period, then subsequent period supply quantities are reduced to consume leftover supplies.



	supp_id	nsn	nomen	div_by	num_pkg	adj_qty	qty01_j	qty02_j	qty03_j	qty04_j	qty05_j	qty06_j	qty07_j	qty08_j	qty09_j	qty10_j
2	1	6505009857301	ACETAMINOPHEN TABLETS 0.325GM 1000S	1000	205	205000	14000	12000	11000	12000	12000	10000	34000	35000	32000	33000
3	4	6515008801832	ADAPTER RIGHT ANGLE ELBOW TRACHEAL ANE	1	256	256	16	15	13	15	16	13	43	44	41	41
4	42343	6515012453463	ADAPTER SYRINGE - TUBING DBL MALE LUER 1(	100	28	2800	300	100	200	100	200	200	400	500	300	500
5	5	6515008801833	ADAPTER Y-PIECE TRACHEAL ANESTHESIA SET	1	256	256	16	15	13	15	16	13	43	44	41	41
6	1661	6505015184153	ADENOSINE INJ 3MG/ML PRE-FILLED 2ML CART	10	408	4080	260	230	220	240	250	200	700	690	640	670
7	8	6510002036010	ADHESIVE TAPE SURG 12IN x5YDS MOLESKIN	1	37	37	4	3	0	3	3	1	6	7	6	4
8	11	6510000033058	ADHESIVE TIES SURG MONTGOMERY 11x 7IN 24	24	187	4488	288	264	240	264	264	240	744	768	696	720
9	12	6515013215211	AIRWAY KIT PERCUTANEOUS EMERGENCY ADU	1	565	565	38	33	28	32	36	28	94	96	90	90
10	13	6515011295437	AIRWAY NASOPHARYNGEAL 28FR 10S	10	91	910	70	50	60	40	70	40	150	150	130	150
11	727	6515011295439	AIRWAY NASOPHARYNGEAL 32FR STER 10S	10	30	300	20	20	20	10	20	20	50	50	40	50
12	14	6515011676637	AIRWAY NASOPHARYNGEAL ROBERTAZZI 30FR	12	39	468	84	0	24	36	0	48	60	84	60	72
13	15	6515009582232	AIRWAY PHARYNGEAL BERMAN DESIGN 80MM 1	12	55	660	48	48	24	48	36	36	108	108	108	108
14	16	6515011649637	AIRWAY PHARYNGEAL CUT AWAY FLANGE 30FF	30	230	6900	570	450	270	450	420	300	1170	1230	1050	990
15	18	6505011169245	ALBUTEROL INHALATION 17GM CONT 200 SPRAY	1	304	304	21	18	16	18	19	16	49	52	48	51
16	1917	6505011464268	ALUMINUM CHLORIDE HEXAHYDRATE SOL 37 ML	1	106	106	7	6	6	6	6	6	18	18	17	17
17	778	6505014731770	ALUMINUM MAGNESIUM TABS 100S	100	78	7800	700	400	400	500	400	400	1300	1300	1300	1100
18	19	6505013038962	AMOXICILLIN & POTASSIUM CLAVULANATE 100S	100	185	18500	1200	1100	900	1100	1100	900	3200	3100	3000	2900
19	2144	6630015008737	ANALYZER BLOOD HAND-HELD AGILENT IRMA	1	793	793	50	48	39	47	48	40	136	133	127	129
20	25	6630014151593	ANALYZER, BLOOD CHEMISTRY, PICCOLO	1	206	206	13	12	11	12	12	11	35	35	33	33
21	783	6515014571840	ANESTHESIA APPARATUS FIELD	1	128	128	8	8	6	8	8	6	22	22	20	21

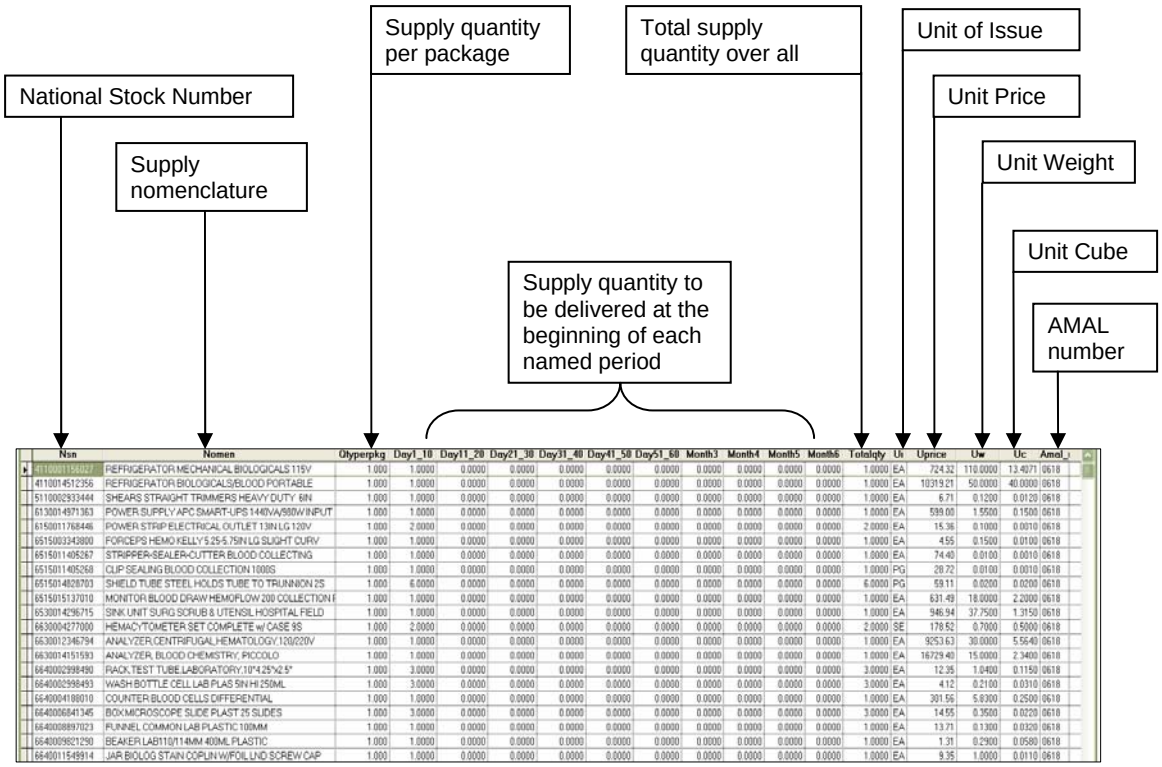
Figure 8. RSVP spreadsheet containing enumerated items, with quantities phased over time periods.



1	amal_num	amal	nsn	nomen	tot_qty	pkgqty	ui	uprice	uw	uc
129	0632	SST/Triage Consumables	6510007219808	SPONGE SURG COTTON GAUZE 4x4IN STERILE 1200S	13200	11	PG	46.6	16	2.2
130	0632	SST/Triage Consumables	6510007755706	PAD ABDOMINAL 7.5 X 8" WHITE 3 LAYERS 240S	240	1	PG	44.48	15	3.195
131	0632	SST/Triage Consumables	6510007822698	SPONGE SURG 8-PLY GAUZE WHITE 4x4IN 200S	23400	117	PG	6.61	0.83	0.073
132	0632	SST/Triage Consumables	6510007822699	SPONGE SURG 12-PLY GAUZE 8x4IN NONSTER 200S	2400	12	PG	22.31	2.4	0.205
133	0632	SST/Triage Consumables	6510007863736	PAD PREP ISOPROPYL ALCOHOL IMPREG 1x2.5IN 100	10400	104	PG	2.23	0.5	0.1
134	0632	SST/Triage Consumables	6510009268882	TAPE ADHESIVE SURG WOVEN 1INx12YD 12S	240	20	PG	7.9	1.41	0.05
135	0632	SST/Triage Consumables	6510009268884	TAPE ADHESIVE SURG WOVEN 3INx10YD 4S	76	19	PG	8.26	1.2	0.05
136	0632	SST/Triage Consumables	6510009355822	BANDAGE ELASTIC ROLLED ACE 4INx4.5YDS 12S	660	55	PG	4.74	2	0.183
137	0632	SST/Triage Consumables	6510009355823	BANDAGE ELASTIC ROLLED ACE 6INx4.5YDS 12S	132	11	PG	21.15	3.25	0.284
138	0632	SST/Triage Consumables	6510012787002	APPLICATOR IMPREG w/BENZOIN 4IN LG 500S	1000	2	PG	14.32	1	0.1
139	0632	SST/Triage Consumables	6510014081920	DRESSING CHEST WOUND SEAL ASHERMAN 10S	30	3	PG	100.71	1.55	0.012
140	0632	SST/Triage Consumables	6510014575844	DRESSING BURN 8x18IN w/WATER-GEL 20S	140	7	PG	103	0.55	0.12
141	0632	SST/Triage Consumables	6515001050759	TUBE ENDOTRACHEAL MURPHY 8.0MM OD 10S	30	3	PG	20.62	1	0.05
142	0632	SST/Triage Consumables	6515001490104	CATHETERIZATION KIT URETHRAL 16FR DISP	165	165	EA	69.79	0.71	0.254
143	0632	SST/Triage Consumables	6515001490316	TUBE STOMACH SURGICAL PLASTIC SALEM 50S	200	4	PG	184.33	4	0.7
144	0632	SST/Triage Consumables	6515006600011	BLADE SURGICAL KNIFE DETACHABLE #10 6S	318	53	PG	0.79	0.03	0.002

Figure 9. The results of distribution, in a spreadsheet containing the quantity of supplies over the entire 180-day period by Authorized Medical Allowance List (AMAL) and National Stock Number (NSN).

Figures 9 and 10 depict examples of supply distribution files that are generated in RSVP and saved to Excel spreadsheets. Figure 9 is organized by AMAL number and description, and contains supply quantities enumerated by unit of issue, weight, cube and cost for the duration of the 180-day period. This allows the user to go through the contents of one discrete AMAL at a time and see quantities and cost by supply item.



Nsn	Nomen	Qtyperpkg	Day1_10	Day11_20	Day21_30	Day31_40	Day41_50	Day51_60	Month3	Month4	Month5	Month6	Totalqty	Ui	Uprice	Uw	Uc	Amal
4110001156027	REFRIGERATOR MECHANICAL BIOLOGICALS 115V	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	724.32	110.0000	13.4071	0618
4110014512356	REFRIGERATOR BIOLOGICALS/BLOOD PORTABLE	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	10319.21	50.0000	40.0000	0618
5110002933444	SHEARS STRAIGHT TRIMMERS HEAVY DUTY 6IN	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	6.71	0.1200	0.0120	0618
6130014571363	POWER SUPPLY APC SMART-UPS 1440VA/980W INPUT	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	599.00	1.5500	0.1500	0618
6150011768446	POWER STRIP ELECTRICAL OUTLET 13IN LG 120V	1.000	2.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.0000	EA	15.36	0.1000	0.0010	0618
6515003343800	FORCEPS HEMO KELLY 5.25-5.75IN LG SLIGHT CURV	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	4.55	0.1500	0.0100	0618
6515011405267	STRIPPER-SEALER-CUTTER BLOOD COLLECTING	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	74.40	0.0100	0.0010	0618
6515011405268	CLIP SEALING BLOOD COLLECTION 1000S	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	PG	28.72	0.0100	0.0010	0618
6515014828703	SHIELD TUBE STEEL HOLDS TUBE TO TRUNNION 2S	1.000	6.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	6.0000	PG	59.11	0.0200	0.0200	0618
6515015137010	MONITOR BLOOD DRAW HEMOFLOW 200 COLLECTION I	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	631.49	18.0000	2.2000	0618
6530014296715	SINK UNIT SURG SCRUB 8 UTENSIL HOSPITAL FIELD	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	946.94	37.7500	1.3150	0618
6630004277000	HEMACYTOMETER SET COMPLETE w/ CASE 9S	1.000	2.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.0000	SE	178.52	0.7000	0.5000	0618
6630012346794	ANALYZER,CENTRIFUGAL,HEMATOLOGY,120/220V	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	9253.63	30.0000	5.5640	0618
6630014151593	ANALYZER, BLOOD CHEMISTRY, PICCOLO	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	16729.40	15.0000	2.3400	0618
6640002998490	RACK,TEST TUBE,LABORATORY,10*4.25*X2.5*	1.000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000	EA	12.35	1.0400	0.1150	0618
6640002998493	WASH BOTTLE CELL LAB PLAS 5IN HI 250ML	1.000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000	EA	4.12	0.2100	0.0310	0618
6640004188010	COUNTER BLOOD CELLS DIFFERENTIAL	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	301.56	5.8300	0.2500	0618
6640006841345	BOX MICROSCOPE SLIDE PLAST 25 SLIDES	1.000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000	EA	14.55	0.3500	0.0220	0618
6640008897023	FUNNEL COMMON LAB PLASTIC 100MM	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	13.71	0.1300	0.0320	0618
6640009821290	BEAKER LAB110/114MM 400ML PLASTIC	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	1.31	0.2900	0.0580	0618
6640011549914	JAR BIOLOG STAIN COPLIN W/FOIL LND SCREW CAP	1.000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	EA	9.35	1.0000	0.0110	0618

Figure 10. A spreadsheet containing information needed to submit a Medical Contigency File (MCF). AMAL indicates Authorized Medical Allowance List.

Figure 10 is organized by NSN number and shows supply quantities to be delivered at the beginning of each period, giving also their unit of issue, weight, cube, and cost, as well as their AMAL number.

Despite following the same process to construct MCF submittals, differences from one to the next may occur, and could be due to differing planning factors, such as battle injury to nonbattle injury ratio, geography, battle intensity, and choice of FAs to populate.

The RSVP capability of calculating equipment quantities and adjusting consumable quantities to ensure packages can be distributed easily amongst the facilities is not used in the MCF submission. To use this capability, the user must input the number of facilities to be deployed at each FA.

Conclusions

There is a vast range of extremely useful future applications for both ESP and RSVP. Both the Navy and the Air Force are using NHRC's modeling process to develop their initial supply configuration models. Once the Air Force Unit Type Codes are baselined in ESP—three are already completed: the Mobile Forward Air Surgical Team,[6] the Critical Care Air Transport Team,[7] and the Global Reach Laydown[8]—the Air Force can use this process for their MCF submissions.

The next supply obstacle is determining equipment sustainment. The assumption under which the services have operated is that equipment lasts an average of 7 years. ESP[9] and RSVP can refine that estimate further, allowing for usage over time, expiration dates, breakage, the natural attrition of heavily used objects, and updating that allows new technologies to emerge and contribute to ameliorating battlefield health care. NHRC has also been using the Tactical Medical Logistics Planning Tool (TML+) for breakage and utilization replacement and updating rates.

An enormous difference in accuracy can be realized, whether trying to populate AMALs with consumables, durables, or equipment, by basing supply estimations on actual patient streams and MTF laydowns like those in the Navy-Marine Corps Combat Trauma Registry (CTR). The CTR is a database of patient encounters that contains information about arrival times, protective equipment, mode and type of injury, disease, symptoms, diagnoses, treatments, medications, treatment facilities, tasks performed, complications, and equipment used. The database is housed at NHRC and is available to become part of ESP's underlying data structure.

Instead of trying to predict casualties and supplies based on probabilities, this wealth of information could inform planner and logistician forecasting. Each PC in the RSVP sustainment model would no longer represent a category of wound or illness but instead an actual patient and their condition. The list of tasks would no longer be proscribed treatment protocols but rather actual tasks performed on the patient, listed out as the information was received from the theater. Supplies would still be calculated from the list of tasks. The RSVP-planned MTF laydown would be replaced by the reporting MTF with a known location.

One advantage of what are called "sense and respond" logistics[10] is that they overcome the inherent inaccuracy of small patient stream forecasts. A small population at risk often results in inaccurate forecasts of supply usage. When the CTR senses supply usage, then resupplies will closely match the supplies used.

Another advantage is the ability to adapt quickly to changing requirements. Supplies that are used at a faster than initially forecast rate will be resupplied at the rate they are being used. Supplies that are not being used as quickly as forecast will not be resupplied as quickly, if at all. Therefore the sense and respond logistics learn from the environment.

Future engagements can use the CTR data to redefine protocol, train personnel, reconfigure AMALs and ADALs, and improve future initial forecasts.

The RSVP MCF process uses a patient stream to generate sustainment supply quantities and delivery schedules. As we move forward, we will be able to use the CTR to track which MTFs are treating which patients and when. Actual patient streams and MTF laydowns will be used instead of those that were forecast. The process described herein will still be useful to calculate supplies from PC codes and supply and resupply management will have fully matured.

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14. ABSTRACT (maximum 200 words)
A brief (approximately 200 words) factual *summary* of the most significant information.

The primary objective of this paper is to explain the process for submitting a Medical Contingency File (MCF) using Naval Health Research Center modeling tools, the Estimating Supplies Program (ESP) and the ReSupply Validation Program (RSVP). MCFs are used by the Defense Center Supply Philadelphia in order to place supply orders with vendors.

ESP links specific clinical requirements to medical procedures, making estimations of supply requirements more reliable and tying them to casualty data. RSVP models supply consumption over time, and produces reports, one of which is the MCF, that were created with medical planners and logisticians in mind. The audit trail produced by the process of running a patient stream through a simulation provides both groups with management tools for ordering, maintaining, and updating supplies, allowing them to see how quantities are utilized.

15. SUBJECT TERMS
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